The 21st International Conference on the Science & Application of Nanotubes & Low-Dimensional Materials

NT21

virtually hosted on June 6-11, 2021, by Rice University

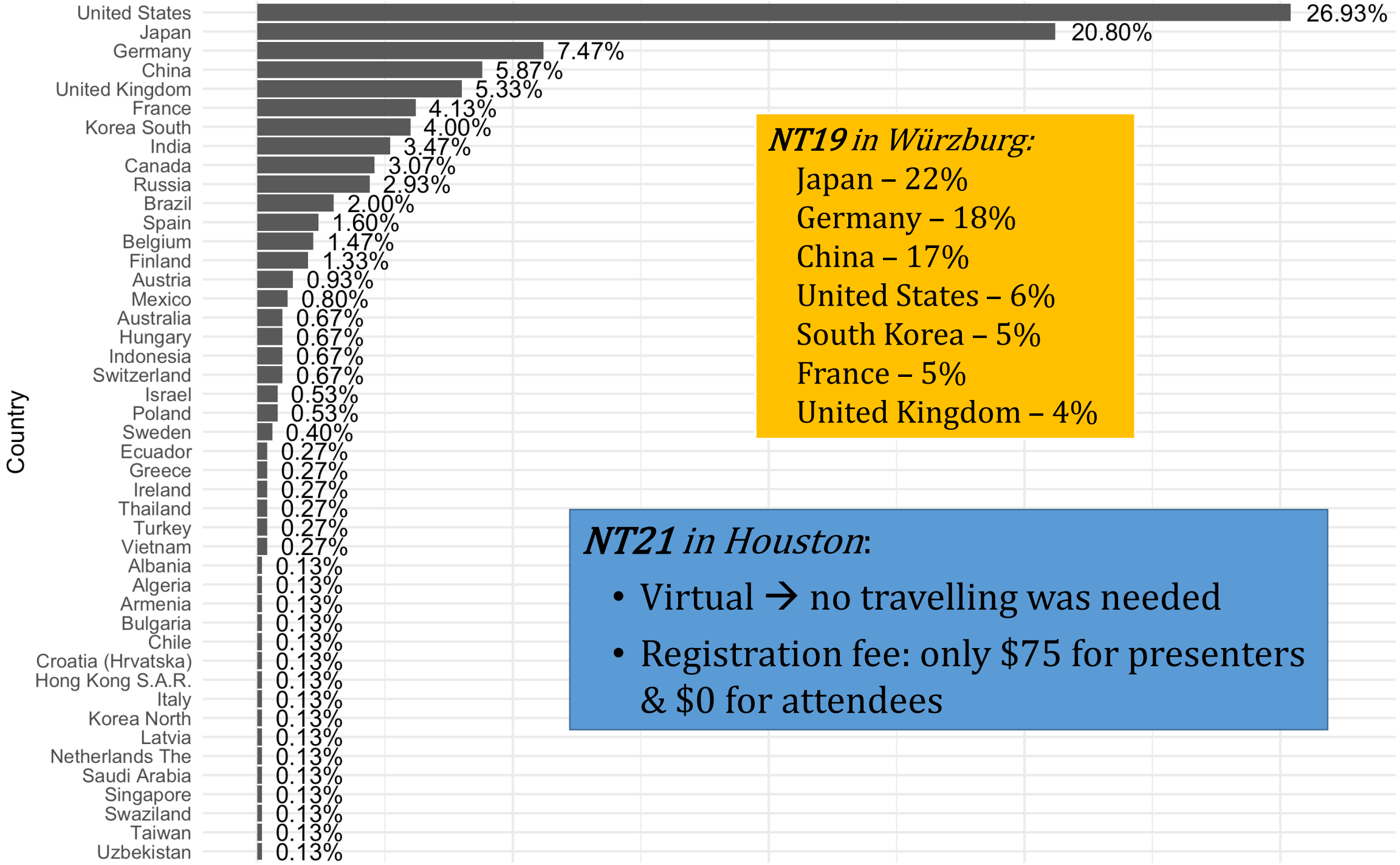
Andrey Baydin,
Postdoc, Kono Group,
Rice University

"So, Jun, what do you mean when you say the conference was a **success**? What is the definition of a **successful** conference?"

“We made it to the end of the conference without disasters! Congrats!”

Many people attended NT21!

We have **1,176** unique attendees who have a recorded login.



***NT19** in Würzburg:*

- Japan – 22%
- Germany – 18%
- China – 17%
- United States – 6%
- South Korea – 5%
- France – 5%
- United Kingdom – 4%

***NT21** in Houston*:

- Virtual → no travelling was needed
- Registration fee: only $75 for presenters & $0 for attendees

Parallel Symposia, Sunday, June 6

	Unique Viewers	Total Users
2nd Synthesis Symposium	274	416
3rd Energy Symposium	97	159
8th Macromaterials Symposium	141	222
11th Biology Symposium	66	135
11th 2D Symposium	87	134
14th Spectroscopy Symposium	106	183
15th Computation Symposium	79	126
	Avg. 121	Avg. 196

Oral Presentations

	Main Conf	Symposia	Total
Keynote	5	0	5
Invited	15	28	43
Contributed	12	25	37
Total	32	53	**85**

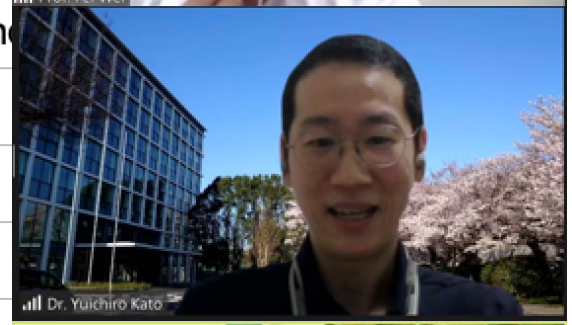
+ **212** Poster Presentations = **297** Presentations

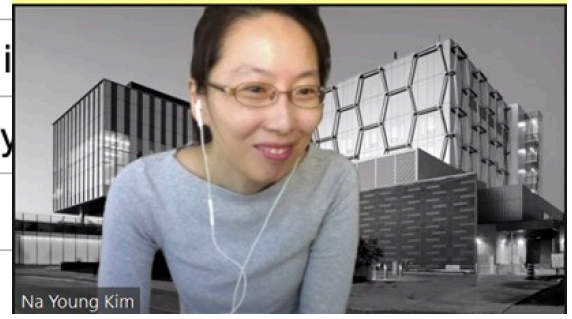
71% poster and **29% oral** presentations

85% poster and **15% oral** contributed presentations

In a virtual conference, everything is recorded.

	Question
1	try to speak without microphone, Prof. Wei
2	very clear now
3	Wei Fei, thank you for impressive talk, as usual. Super long, defect free, semi-conductor DWCNT with 2 nm dia
4	'@Fei Wei. Very interesting work! Do I understand correctly that this CNT growth preferentially yields double an
5	Hi, Prof. Wei, what is the reason that the catalyst activity of m-CNT decay so much faster than that of s-CNT?
6	Nice talk! Why do the metallic tubes have higher defect densities?
7	That is fantastic. What is the diameter of the inner tubes in the 4" wafer of nanotubes that you have grown?
8	great talk! could you elaborate the mechanism behind the metal/semiconductor selectivity on growth?
9	only certain diameter of tube is growing longer, is it because of the catalytic metal particle stable?
10	Excellent talk, Prof. Wei. What is the length limit of SWCNTs with a single chirality?
11	Great work Seung Min! Are you able to model the size of the catalyst as a function of position for your different injection points?
12	To Dr. Kim: In the case of deep injection, the sharp temperture increase will probably build pressure within the i
13	in deep injection case if flow has been raise residence time has been reduced then what contribute increased y
14	Thank you. What is the Fe: S ratio at the optimized condition. Is it the same for the catalyts after growth?
15	did you use rarefied gas or viscous fluid model for the fluid dynamics simulations?





In a virtual conference, everything is recorded and can be viewed later.

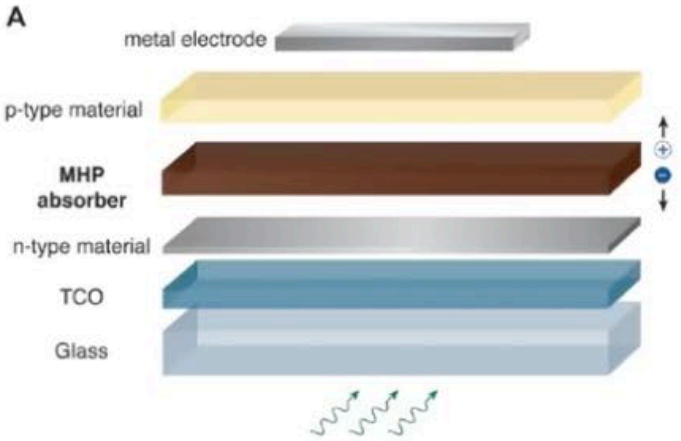
Carbon Nanotubes in Perovskite Solar Cells

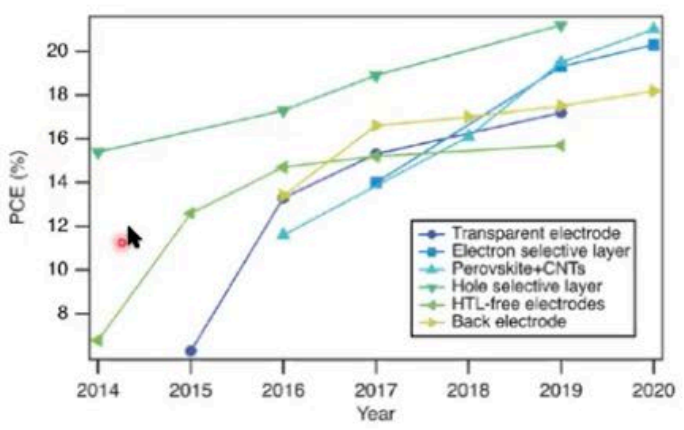
New Perspective:

Carbon nanotubes in high-performance perovskite photovoltaics and other emerging optoelectronic applications

Severin N. Habisreutinger and Jeffrey L. Blackburn[a)]

J. Appl. Phys. **129**, 010903 (2021)





CHOISE | 5

The tutorial talk videos have been watched by 1015 people with 256 complete views.

Michael Arnold (Univ. of Wisconsin), "Carbon Nanotube Electronics"

591 views
(115 complete)

Benji Maruyama (Army Research Lab), "Carbon Nanotube Synthesis: Past, Present and Future"

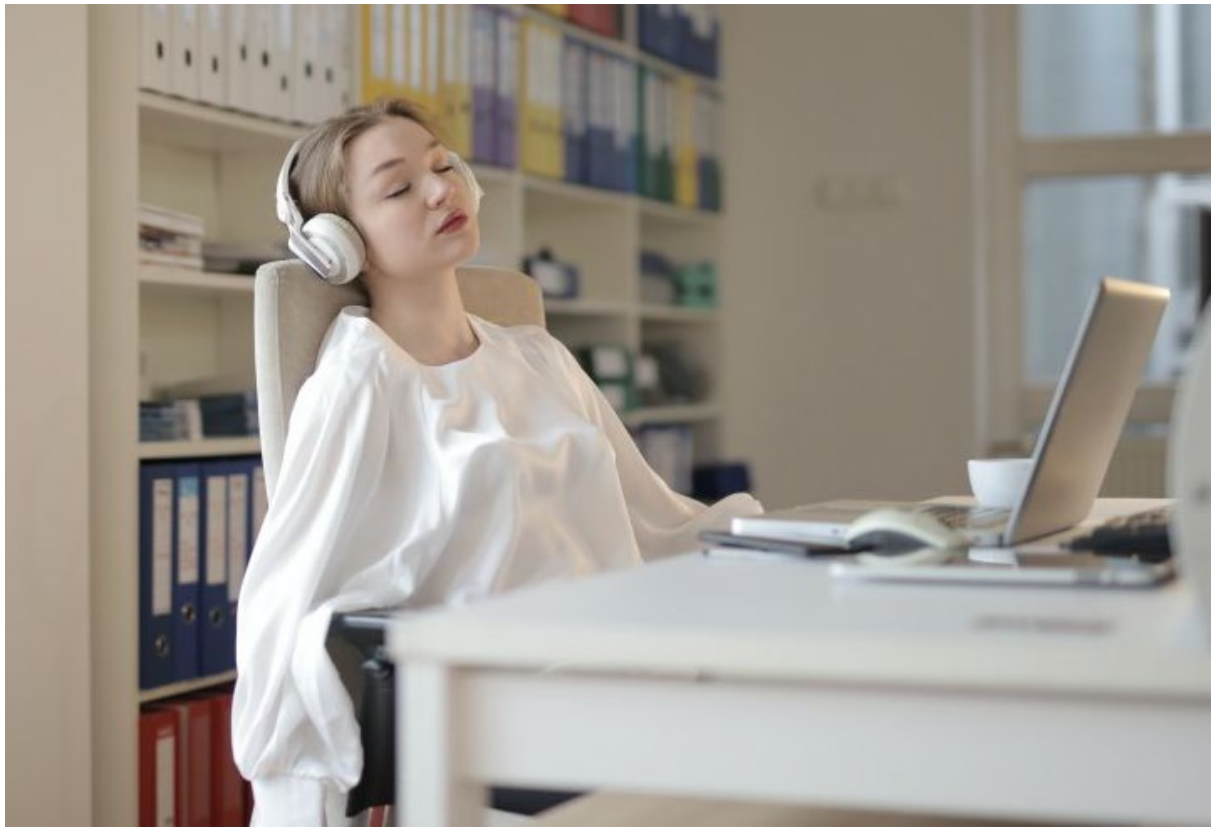
233 views
(78 complete)

Philippe Poulin (CNRS Bordeaux), "Liquid Processing of Carbon Nanotubes"

191 views
(63 complete)

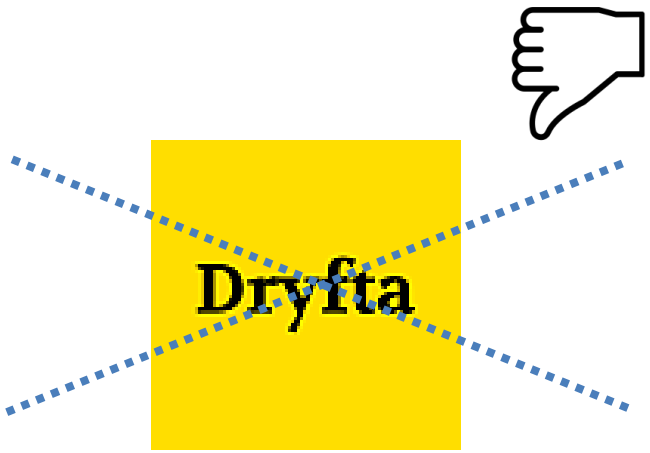
Houston	Paris	Tokyo
		
7–11 am	2–6 pm	9 pm – 1 am

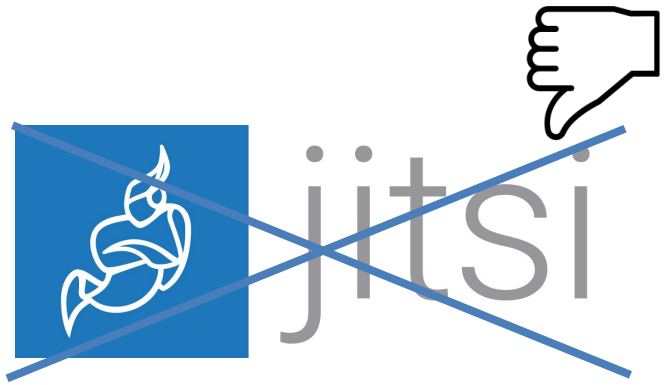
The main challenge was that we did not know whether attendees were attentive.



We missed a live audience …

Finding a suitable online platform was also a major hurdle, as most are not reliably accessible by attendees in China.





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+

7 Student Workers

+

14 Moderators

+

66 Poster Judges

Supplementary Information

Time Zones			Symposium Schedule – Sunday, June 6						
Houston (UTC-5)	Paris (UTC+2)	Tokyo (UTC+9)	2nd Symposium on Synthesis, Purification, Functionalization, and Manufacturing of Carbon Nanotubes and Low-Dimensional Materials	3rd Symposium on Nanocarbon Materials for Energy and Sustainability	8th Symposium on Carbon Nanotube Macromaterials and Their Electronic, Thermal, and Structural Properties	11th Symposium on Carbon Nanomaterials Biology, Medicine and Toxicology	11th Graphene and 2D Materials Symposium	14th Symposium on Nanotube Spectroscopy, Photonics, and Applications in Metrology	15th Symposium on Computational Challenges in Nanotubes, 2-D Materials, and Their Macroscopic Assemblies
6:45	13:45	20:45	Opening	Opening	Opening	Opening	Opening	Opening	Opening
7:00	14:00	21:00	**Renu Sharma** "Revealing the nucleation, growth mechanisms and role of catalyst of single walled carbon nanotube growth"	**Michael De Volder** "3D CNT Current Collectors for Li-Ion Batteries"	**Andrey Khlobystov** "Chemistry in the World's Tiniest Test Tube"	**Rachel Meidl** "Accelerating the Energy Transition with Carbon Nanotubes Requires Closing Critical Policy Gaps and an Understanding of Nano-related Environment, Health and Safety Information"	**Dmitri Efetov** "Competing phases of correlated Chern insulators in Superconducting Twisted Bilayer Graphene"	**Shohei Chiashi** "Synthesis of single-walled carbon nanotube @ boron nitride nanotubes and their optical properties"	**Feng Ding** "Contact-Induced Phase Separation of Alloy Catalyst to Promote Carbon Nanotube Growth"
7:30	14:30	21:30	**Suguru Noda** "Enhancing Carbon Nanotube Production via Careful Control over Catalyst"	**Dawid Janas** "Is Nanocarbon Black, Green, or Both? Towards Sustainable Energy with Carbon Nanotubes"	**Chris Ewels** "1D-nanomaterial confinement: Red-phosphorus encapsulated within single-walled carbon nanotubes"	**Ardemis Boghossian** "Bioengineering DNA-based Optical Nanotube Sensors Using Directed Evolution and Xenonucleic Acids (XNAs)"	**Guillaume Cassabois** "Deep-ultraviolet spectroscopy in hexagonal boron nitride: from bulk to monolayer"	**Salomé Forel** "Calibrating Raman Cross-sections of Sorted SWCNT Samples"	**Boris Yakobson** "New Theory Insights in 1D-Nanotubes and 2D-Layers Growth and Properties"
8:00	15:00	22:00	**Arthur Sloan** "Rapid Feedback Experimentation for Continuous Carbon Nanotube Growth"	**IL Jeon** "Foldable Perovskite Solar Cells Using Carbon Nanotube-Embedded Ultrathin Polyimide Conductor"	**Filchito Renee Bagsican** "Carrier-Exciton Dynamics in Aligned and Random Semiconducting Carbon Nanotubes Probed by Terahertz Emission and Photocurrent Spectroscopy"	**Robert Nißler** "Detection of Plant Polyphenols via Near Infrared Fluorescent SWCNT Nanosensors"	**Kai Liu** "Laser Direct Writing of 2D Transition Metal Chalcogenides/Oxides Heterostructures"	**Laurent Cognet** "Tailoring Carbon Nanotubes to Propel Super-resolution Microscopy Applications at Near-Infrared Wavelengths"	**Zhao Wang** "Aligned Carbon Nanotubes and Twisted Bilayer Graphene as Linear Nanoactuators"
8:15	15:15	22:15	**Jiangtao Wang** "Selectively Twisting Carbon Nanotubes into Semiconducting Chiralities by Low-Work-Function Contact"	**Gideon Oyibo** "Harnessing the Photovoltaic Properties of Carbon Nanotube Networks"	**Alexander Tonkikh** "Tunable Doping and Characterization of Single-Wall Carbon Nanotube Macrosystems in Air"	**Lorena García-Hevia** "The CNT Biocorona: A Challenge in Nanobiotechnology"	**Sunny Gupta** "What Dictates Rashba Splitting in 2D van der Waals Heterobilayers?"		**Umedjon Khalilov** "Catalyst-Feedstock Tandem in the Structure Synthesis inside a Carbon Nanotube"
8:30	15:30	22:30	Break	Break	Break	Break	Break	Break	Break
8:45	15:45	22:45	**Benjamin Flavel** "The Effect of Endohedral Filling on Separation"	**Juan José Vilatela** "High-Performance Materials Based on Nanoscopic Building Blocks: From Composites to Electrodes"	**Thomas Pichler** "Unravelling the Properties of Carbyne Confined inside Carbon Nanotubes"	**Dan Roxbury** "Multispectral Fingerprinting Resolves Dynamics of Nanomaterial Trafficking in Primary Endothelial Cells"	**Ajit Srivastava** "Interacting Excitons in van der Waals Heterostructures of TMDs"	**Paul Finnie** "Full Spectrum Raman Excitation Mapping of Carbon Nanotubes and Making Raman Spectroscopy More Metrological"	**Nicola Marzari** "Computational Exfoliation of All Inorganic Materials, and What One Can Find There"
9:15	16:15	23:15	**Wei Sun** "DNA-directed precise pitch-scaling for high-performance CNT FETs"	**Andrew Ferguson** "Harvesting Radio-frequency Signals with Carbon Nanotube Electronic Ratchets"	**Esko Kauppinen** "SW, DW and FW CNTs and Graphene-CNT Hybrids for Flexible Electronics Applications"	**Matteo Palma** "Protein Site-Specific Coupling to Carbon Nanotubes: From Single-Molecule Nanohybrids to Nanoscale Biosensors with Tuned Electrostatic Gating"	**Aditya Mohite** "Semiconductor Physics of 2D Organic-Inorganic Perovskites"	**Edward Egelman** "Application of Cryo-EM to DNA-CNTs"	**Tony Low** "2D materials plasmons: physics and applications"
9:45	16:45	23:45	**Christopher Sims** "Determining SWCNT Extraction Conditions in Aqueous Two-Polymer Phase Extraction with Near-Infrared Fluorescence"		**Qiang Zhang** "Transparent and Freestanding Single-Walled Carbon Nanotube Films Synthesised Continuously via Floating Catalyst Chemical Vapor Deposition"	**Zvi Yaari** "Machine Learning Enabled Nanosensor Array Platform for Cancer Diagnosis"	**Ksenia Bets** "Lateral Epitaxy: the Entropic Source of Ordered Monocrystalline Growth of 2D Materials"	**Achim Hartschuh** "Time-resolved Optical Microscopy of Single Semiconducting Carbon Nanotubes"	**Igor Bondarev** "Collective Excitations and Optical Response of Ultrathin Carbon Nanotube Films"
10:00	17:00	0:00 +1	**Jan Gotthardt** "Molecular n-Doping of Large- and Small-Bandgap Carbon Nanotube Field-Effect Transistors with ttmgb"		**Cedric Ginestra** "Liquid Crystals of Neat Boron Nitride Nanotubes and their Assembly into Ordered Macroscopic Materials"	**Nicole Iverson** "In Vivo Detection and Tissue Extraction of Single Walled Carbon Nanotube Sensors from a Large Animal Model"	**Chongwu Zhou** "Gold-Vapor-Assisted Chemical Vapor Deposition of Aligned Monolayer WSe_2 with Large Domain Size and Fast Growth Rate"	**Klaus Eckstein** "Comparison of Infrared and Raman Spectra of Doped (6,5) Single-Wall Carbon Nanotubes"	**Grigorii Drozdov** "Densification of Single-Walled Carbon Nanotube Films: Mesoscopic Distinct Element Method (mDEM) Simulations and Experimental Validation"
10:15	17:15	0:15 +1	Welcome Reception						

Time Zones			Daily Schedule					
Houston (UTC-5)	Paris (UTC+2)	Tokyo (UTC+9)	Sunday, June 6	Monday, June 7	Tuesday, June 8	Wednesday, June 9	Thursday, June 10	Friday, June 11
6:30	13:30	20:30		**Opening Session:** remarks by Prof. Robert Curl, Nobel Laureate, and David Leebron, President of Rice University				
7:00	14:00	21:00	**Parallel Symposia** See detailed program below	**Zhiping Xu** "Morphogenesis of Assembled Carbon Nanostructures Towards High-performance Materials"	**Yuan Chen** "Carbon Nanomaterial Enabled Oxygen Electrocatalysts"	**Fei Wei** "Directed Evolution of Carbon Nanotube Growth and its Unique Properties"	**Yoshihiro Iwasa** "Symmetry Engineering in Nanotubes and Heterostructures of Transition Metal Dichalcogenides"	**Masako Yudasaka** "Imaging of Brown Adipose Tissues by Using Carbon Nanotubes as NIR Fluorescent Probes"
7:30	14:30	21:30		**Jong-Hyun Ahn** "Skin-attachable Sensor Based on Graphene"	**Sarah Haigh** "Developing Twisted, Stacked 2D Heterostructures with Atomic Resolution In Situ Imaging and Vice-versa"	**Seung-Min Kim** "The Effects of Gas Flow Patterns and Configurations of Injection Part of Reactor on the Synthesis of Carbon Nanotube/Carbon Nanotube Fiber"	**Alain Penicaud** "Raman D Band Appears upon Folding: The Case of Flattened Carbon Nanotubes"	**Ralph Krupke** "Electroluminescence from Graphene-Contacted (7,5) Carbon Nanotubes with Defects"
8:00	15:00	22:00		**Hiromichi Kataura** "Separation of Metallic Single-chirality Carbon Nanotubes Using Gel-column Chromatography"	**Vincent Jourdain** "Dynamic Instability of Individual Carbon Nanotube Growth Revealed by In Situ Optical Imaging"	**Yuichiro K. Kato** "Near-unity Radiative Quantum Efficiency of Excitons in Carbon Nanotubes"	**Wim Wenseleers** "Well-defined Armchair Graphene Nanoribbons Synthesized inside Carbon Nanotubes"	**Rufan Zhang** "Synthesis and Applications of Ultralong Carbon Nanotubes"
8:15	15:15	22:15		Break	Break	Break	Break	NT22 Announcement
8:30	15:30	22:30		**Pulickel Ajayan** "Carbon Nanotechnology: A Timeline"	**Ute Kaiser** "Understanding Electron-beam-stimulated Reactions within Functionalized Low-dimensional Materials"	**Kaili Jiang** "Synthesis and Applications of Carbon Nanotubes"	**Riichiro Saito** "Optical Properties of Nanotubes and 2D Materials"	**Jana Zaumseil** "Purified and Functionalized CNTs for Optical and Electronic Applications"
9:15	16:15	23:15		**Adam Boies** "Pushing the Bounds of CNT Floating Catalyst Synthesis Quality Versus Quantity"	**James Tour** "Flash Graphene. Trash to Treasure"	**Jing Kong** "Synthesis and Electrical Contact to Two Dimensional Materials"	**Jeffrey Blackburn** "SWCNT Heterojunctions with Low-dimensional Perovskites for Novel Optoelectronic Functionality and Devices"	**Markita Landry** "Carbon Nanotubes Enable Delivery of Biomolecules to Plants Without Transgene Integration"
9:45	16:45	23:45		Break	**Poster I** Sessions A–E	**Poster II** Sessions A–E	**Poster III** Sessions A–E	Break
10:00	17:00	0:00 +1		**Chongwu Zhou** "High-performance Radio-frequency and Nano Electronics Based on Assembled High-density and High-semiconducting-purity Carbon Nanotube Films"				**Vasili Perebeinos** "Electrical Conductance Mechanisms in Carbon Nanotube Films"
10:15	17:15	0:15 +1	**Welcome reception** on gather.town	**Alice Castan** "Determining SWCNT Chiralities from High Resolution Electron Microscopy Images using Deep Learning"				**Todd Krauss** "The Light, the Dark, and the Role of Charges and Defects in Carbon Nanotubes"
10:30	17:30	0:30 +1		**Mijin Kim** "In Vivo Nanosensors using Organic Color Centers for Pharmacodynamic Monitoring"				**Ethan Minot** "Extremely Efficient Photocurrent Generation in Individual Carbon Nanotube Photodiodes"
10:45	17:45	0:45 +1		**Katherine Jinkins** "Wafer-scale Alignment of 2D Carbon Nanotube Liquid Crystals for Electronics"				**Awards & Closing**

	Main	Symposia	Total
Keynotes	5	0	5
Invited	15	28	43
Contributed	12	25	37
Total	32	53	85

The 10th NT was called NT09!

The previous record: **850**

20th International Conference on the Science and Application of Nanotubes and Low-Dimensional Materials

21-26 July 2019 Würzburg, Germany

The 21st NT is held in 2021!

Honolulu

2–6 am

NT21 Sponsors

Thank you for joining NT21!